DRL NO. 91
ORD NO. SE-6

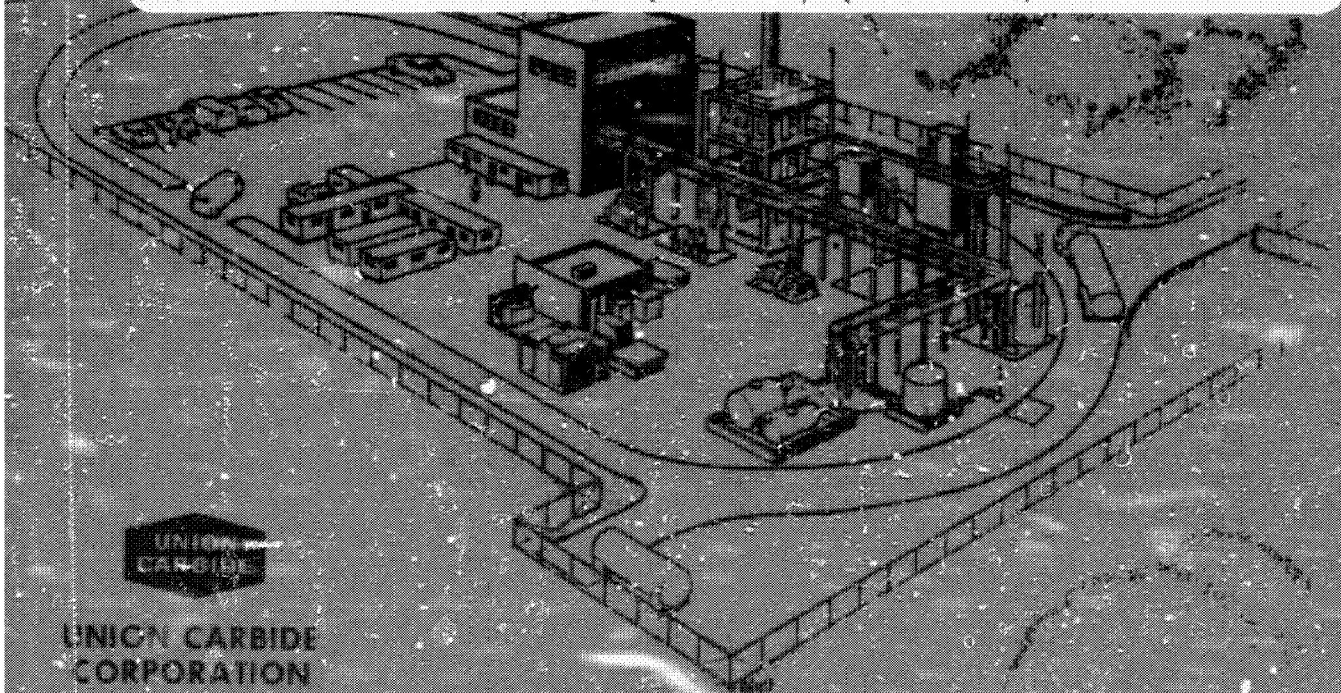
DOE/JPL 954334 – 19
Distribution Category UC - 63

QUARTERLY PROGRESS REPORT

APR – JUNE 1981

low cost solar array project

EXPERIMENTAL PROCESS SYSTEM DEVELOPMENT UNIT FOR PRODUCING SEMICONDUCTOR-GRADE SILICON USING THE SILANE-TO-SILICON PROCESS



UNION CARBIDE CORPORATION

THE JPL LOW-COST SOLAR ARRAY PROJECT IS SPONSORED BY THE U.S. DEPARTMENT OF ENERGY AND FORMS PART OF THE SOLAR PHOTOVOLTAIC CONVERSION PROGRAM TO INITIATE A MAJOR EFFORT TOWARD THE DEVELOPMENT OF LOW-COST SOLAR ARRAYS. THIS WORK WAS PERFORMED FOR THE JET PROPULSION LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY BY AGREEMENT BETWEEN NASA AND DOE.

DRL NO. 81
DRD NO. SE-6

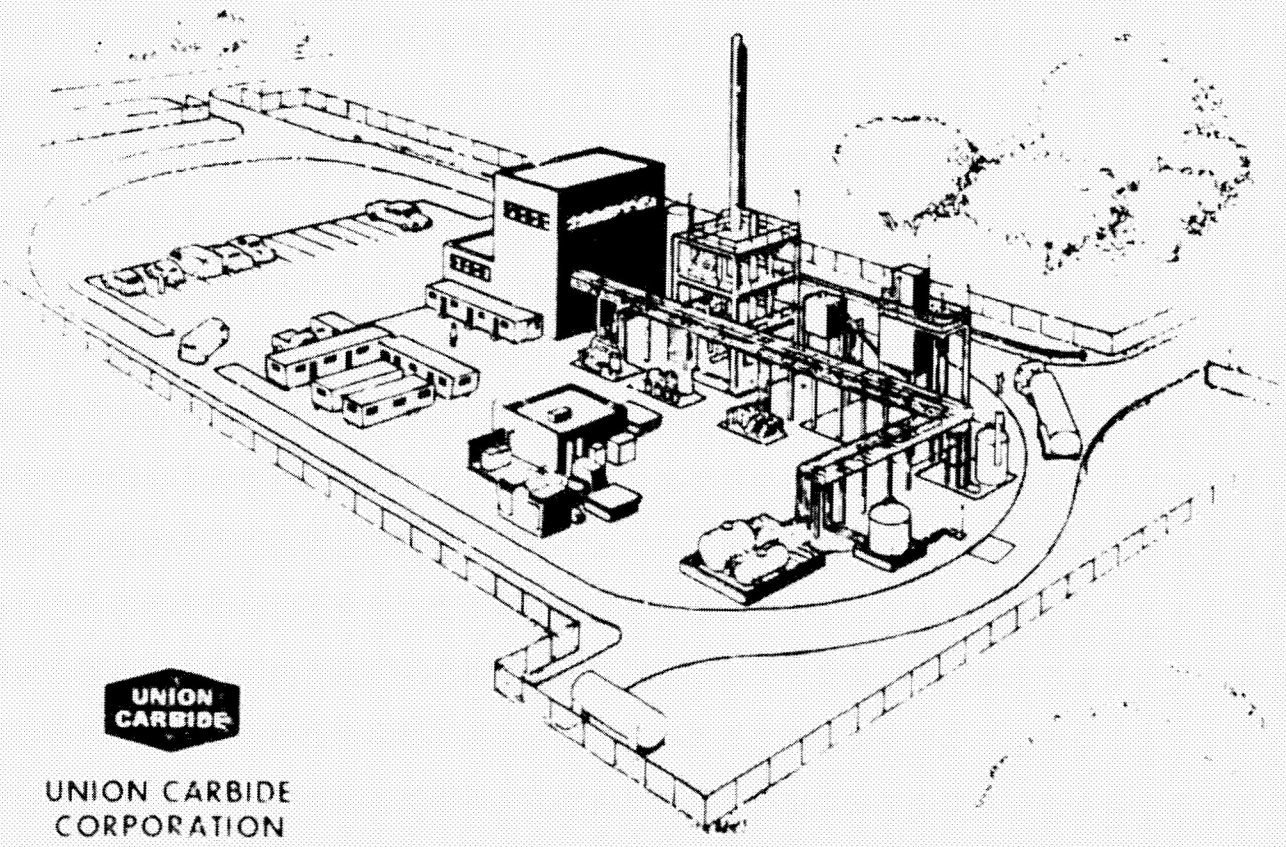
DOE/JPL 954334 – 19
Distribution Category UC - 63

QUARTERLY PROGRESS REPORT

APR – JUNE 1981

low cost solar array project

EXPERIMENTAL PROCESS SYSTEM DEVELOPMENT UNIT FOR PRODUCING SEMICONDUCTOR GRADE SILICON USING THE SILANE-TO SILICON PROCESS



UNION CARBIDE CORPORATION

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

TABLES

ILLUSTRATIONS

ABSTRACT

This report covers work performed in April, May and June, 1981 on JPL/DOE Contract 954334, Phase III. This phase consists of the engineering design, fabrication, assembly, operation, economic analysis, and process support R&D for an Experimental Process System Development Unit (EPSDU).

The mechanical bid package was issued and the bid responses are under evaluation. Similarly, the electrical bid package was issued, however, responses are not due until the third quarter. The majority of all equipment is on order or has been received at the EPSDU site.

The pyrolysis/consolidation process design package was issued. Preparation of process and instrumentation diagram for the free-space reactor has been started.

In the area of melting/consolidation, Kayex have successfully melted chunk silicon and have produced silicon shot. The free-space reactor powder was successfully transported pneumatically from a storage bin to the auger feeder twenty-five feet up and was melted.

The fluid-bed PDU has successfully operated at silane feed concentrations up to 21%.

The writing of the operating manual has started. Overall, the design phase is nearing completion. Activity for the third quarter will be starting the mechanical and electrical subcontract activity and making preparation plans for running the plant.

SECTION I. INTRODUCTION

This report covers work performed in April, May and June, 1981 on JPL/DOE Contract 954334, Phase III.

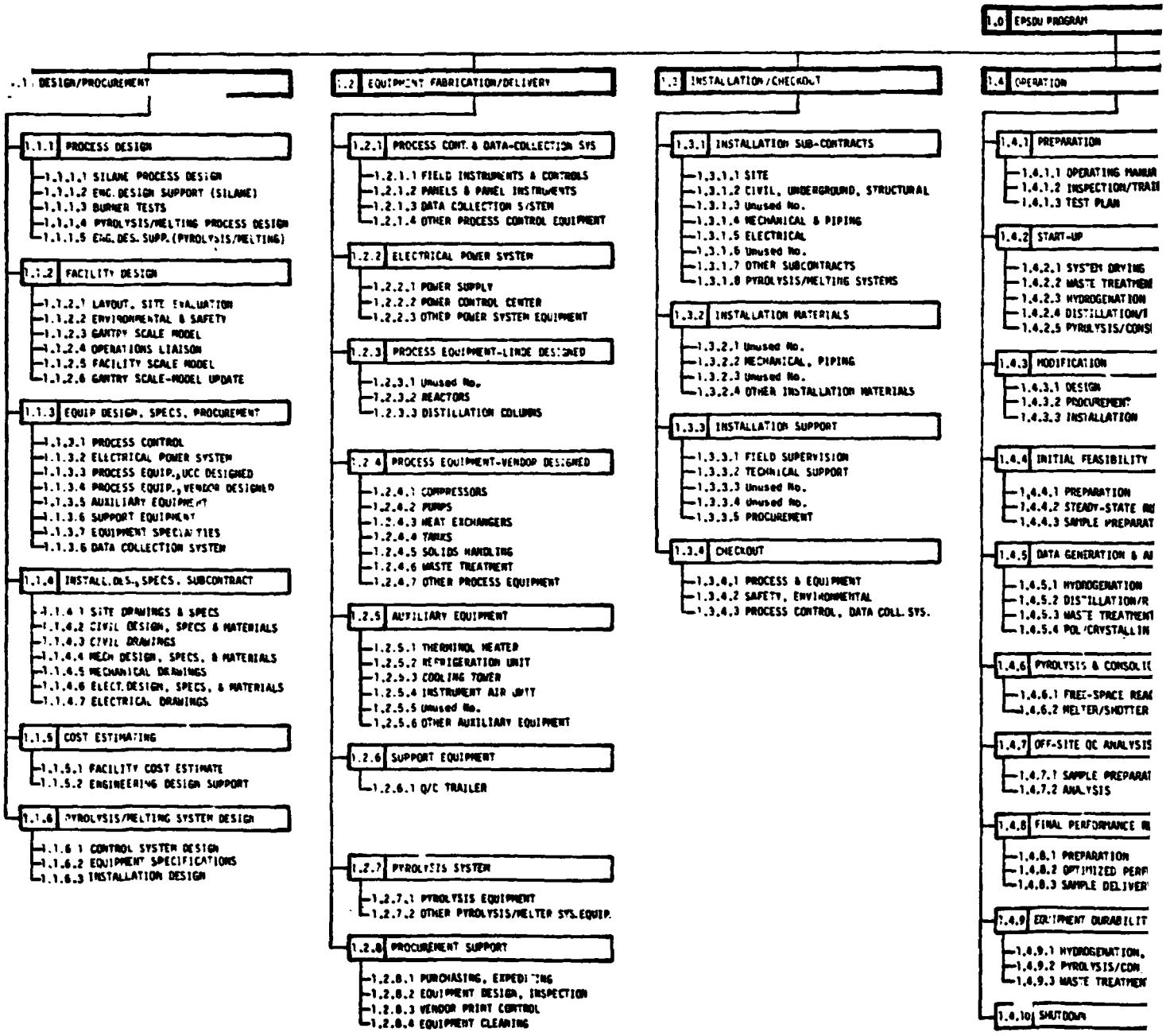
The overall objective of the LSA Silicon Material Task is to establish a chemical process for producing silicon at a rate and cost commensurate with the production goals of the LSA project for solar-cell modules. This material must be suitable for utilization in the large-area sheet process and in the automated process for the fabrication of solar cells having satisfactory physical and electrical performance characteristics.

As part of the overall Silicon Material Task, Union Carbide developed the silane-silicon process and advanced the technology to the point where it has a definite potential for providing high-purity polysilicon on a commercial scale at a price of $14/kg by 1986 (1980 dollars). This work, completed under Phases I and II of the contract, provided a firm base for the Phase III Program (initiated in April 1979) aimed at establishing the practicality of the process by pursuing the following specific objectives:

- Design, fabricate, install, and operate an Experimental Process System Development Unit (EPSDU) sized for 100 MT/Yr to obtain extensive performance data to establish the data base for the design of commercial facilities.

- Perform supporting research and development to provide an information base usable for the EPSDU and for technological design and economic analysis for potential scale-up of the process.

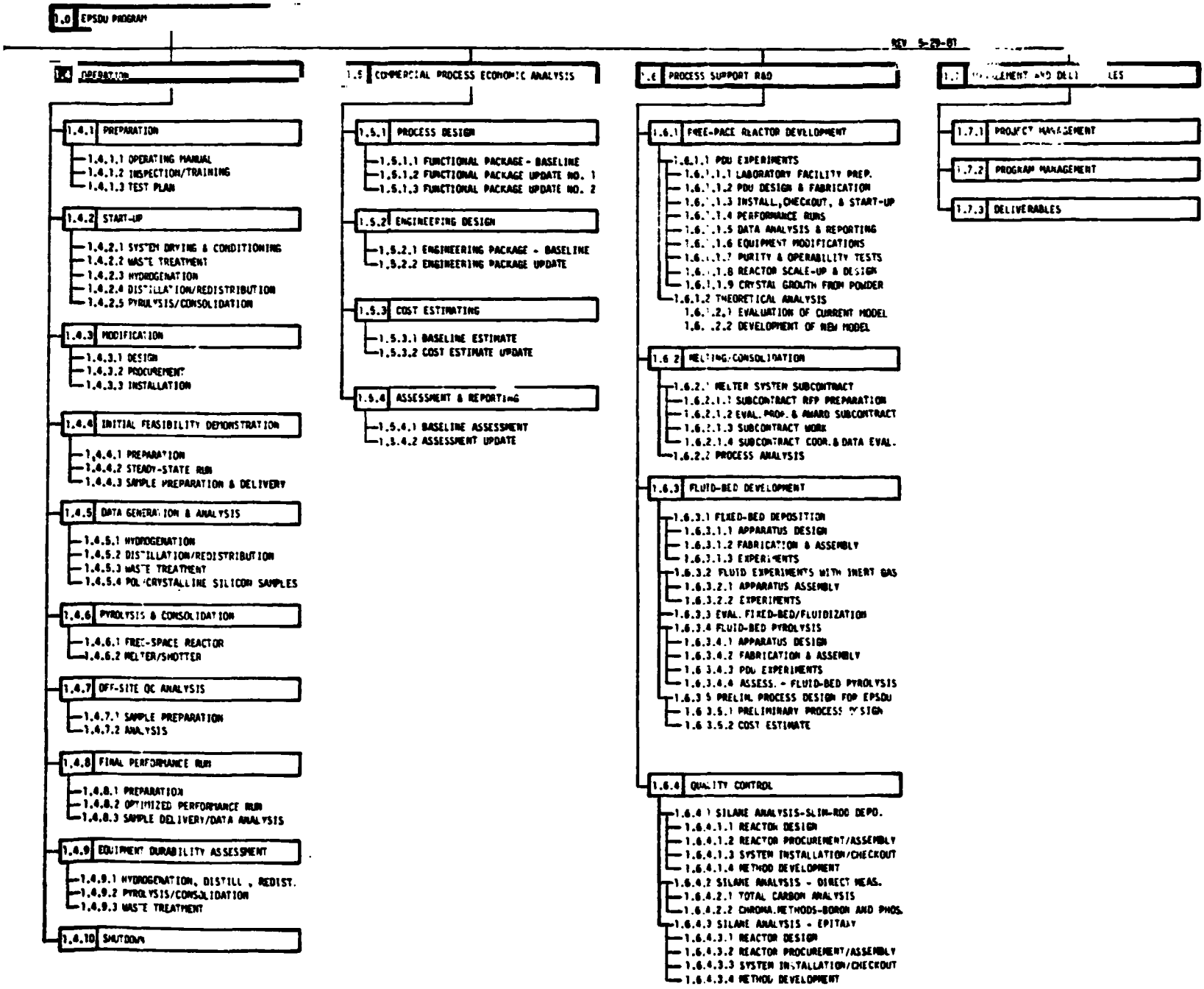
- Perform iterative economic analyses of the estimated product cost for the production of semiconductor-grade silicon in a facility capable of producing 1000 MT/Yr.



FOLDOUT FRAME

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE I
WORK BREAKDOWN STRUCTURE
REVISED FOR FY81, 82, & 83



FOLDOUT FRAME 2

This process for preparing semiconductor-grade silicon in the EPSDU from metallurgical-grade (M-G) silicon is based on a well-integrated arrangement of purification steps that provides a cost-effective process system.

The three basic steps entail converting M-G silicon to trichlorosilane, redistributing the trichlorosilane to produce silane, and thermally decomposing the silane to form silicon powder. The powder is then melted and the molten silicon is cast into polycrystalline silicon for subsequent use in fabricating solar cells.

The technical progress presented in this report is arranged according to the Work Breakdown Structure (WBS) shown in Table I.

SECTION II. TECHNICAL ACTIVITIES (BY WBS NUMBER)

1. EPSDU PROGRAM

As illsutrated in Table I, the current Phase III Program consists of seven primary (WBS level 2) divisions of effort:

- EPSDU Design and Procurement
- EPSDU Equipment Fabrication and Delivery
- EPSDU Installation and Checkout
- EPSDU Operation
- Commercial (1000 MT/Yr) Process Economic Analysis
- Process R&D to Support EPSDU Design and Commercial Analysis
- Program Management

Collectively, these activities encompass all efforts required to attain the program objectives. The subdivisions (WBS levels 3, 4, and 5) define the individual work items that must be performed. The progress for this quarter, documented in this section, is reported at the work-item level.

1.1 EPSDU DESIGN/PROCUREMENT

This effort includes all engineering, design, and procurement activities necessary to transform the process design, developed during the Phase II Program, into a complete installation-drawing package for EPSDU. The major tasks include process design updates, facility design, equipment design and procurement, installation design, and cost estimating support.

1.1.1 Process Design

The process design effort is geared toward using the most recent information available to provide the most practicable integration of process subsystems for attaining the EPSDU Program objectives. The process design package consists of a heat/mass balance, process description, process flow

diagram, and functional specifications for process equipment. The original package, issued in June 1979, served as the basis for the subsequent engineering effort. Beneficial data from the supporting R&D effort and other process-related analyses and experiments were used to update the original package. Process engineers, using information available from the Phase I and Phase II Programs, provide direct support to the facility and equipment design efforts.

1.1.1.2 Engineering Design Support

Process design activity during this quarter consisted of providing support to the engineering department by reviewing the mechanical design bid package from the process viewpoint and participating at the jobsite bidders meeting. The updated gantry model and the mechanical piping design were compared for accuracy and the differences will be corrected.

The logic diagram was reviewed with the instrument engineer and the final logic diagram will be issued in July.

1.1.1.4 Pyrolysis/Consolidation Process Design

Process Design Package

The process design package for the pyrolysis/consolidation section was completed and issued in June. This design package will be used as the basis for developing P&I diagrams and design in Task 1.1.6 (Pyrolysis/Melting System Design). The text is divided into ten sections viz:

1. Process Description
2. Process Flow Diagram
3. Heat and Mass Balance
4. Equipment List and Functional Specifications
5. Preliminary Layout
6. Utility Requirements
7. Special Requirements
8. Safety Considerations and Information
9. Shotting Tower Drawings
10. Free-Space Reactor Fabrication Design

Process Flow Diagram, Heat and Mass Balance

A process flow diagram was developed to show the interconnections between equipment items. A heat and mass balance analysis was made for the process and a stream catalog developed defining temperature, pressure, flow rate, molecular weight and composition of each fluid.

Process Description

Silane is withdrawn from the top of the Silane Storage Tanks, the contents of which have been analyzed to confirm adequate purity. The pressure and flow controlled silane is injected into the Free-Space Reactor through a water-cooled stainless steel nozzle. The walls of the reactor are heated to 900°C by the Free-Space Reactor Pyrolysis Furnace. This is an electrical resistance multi-zone furnace which is connected to plant power through the Free-Space Transformer. Energy is transferred convectively from the reactor walls to the entering silane jet via recirculating product hydrogen and silicon. Above 760°C the silane rapidly decomposes according to:

$$SiH_4\ (g) \rightarrow Si\ (s) + 2H_2\ (g)$$

The reaction is essentially complete before the silane reaches the walls of the reactor, thus precluding any hard deposit formation. The product silicon is in the form of a very fine (0.4 μm) powder which is periodically stripped from the reactor wall by a mechanical scraper. The silicon is separated from its hydrogen carrier by porous metal filters located in the lower chamber of the reactor. The pyrolysis hydrogen exits the hopper, is cooled to 100°F in two steps against cooling water (Pyrolysis Hydrogen Precooler, and Pyrolysis Hydrogen Cooler), and enters the first stage of the Pyrolysis Hydrogen Recycle Compressor. A portion of the hydrogen is recycled from the first stage to the Free-Space Reactor and to the shotter assembly. The remainder enters the second stage of the compressor and serves as make-up hydrogen to the hydrogenation reactor.

The silicon powder in the lower reactor is cooled by recycle hydrogen and the cooled powder periodically is dense-phase-conveyed to the Shotter Feed Hopper. Compressed hydrogen stored in the Hydrogen Accumulator maintains hopper pressure during conveying. Following atmosphere exchange with argon the powder is fed to the Shotter via a variable speed screw auger. The

powder is then melted and forced through a (nominal) 1 mm orifice to form (nominal) 2 mm shot. The shot solidifies in the shotter drop tube and is cooled to close to ambient by recirculating hydrogen in the Shot Receiver. The hydrogen used is cooled against cooling water in the Shot Receiver Hydrogen Recycle Cooler, filtered, boosted in pressure by the Shot Receiver Hydrogen Recycle Blower and reintroduced into the Receiver. Cooled shot is removed via the Shot Lockhopper and drummed. The collected shot is weighed on the Shot Scale and sent to storage.

Powder produced in excess of the shotter's capability is conveyed to the Excess Powder Hopper. Following atmosphere exchange with nitrogen, the powder is conveyed into drums, weighed on the Powder Scale and sent to storage.

Equipment

An equipment list was prepared along with functional specifications for each of 27 equipment items. A preliminary layout of the Pyrolysis/ Consolidation building was developed which shows the location of equipment, items related to Q.C., utilities and non-process related features.

Silicon Powder Properties

An analysis of the flow properties of the free-space reactor silicon powder was made to determine design parameters for a transport system.

1.1.2 Facility Design

The gantry scale model requires updating to conform to the current design. The facility model has not been completed. The model work for both has been delayed due to the model shop heavy workload.

1.1.3 Equipment Design, Specification, Procurement

The equipment related effort includes development of the control system, preparation of the piping and instrumentation diagram, preparation of wiring schematics and control panel drawings, and the design of equipment. The specification activity includes definition of specific requirements for each item of equipment, preparation of bid packages, evaluation of vendor

quotation, and preparation of final specifications and drawings. Procurement includes the issuance of procurement packages to selected vendors and obtaining comprehensive design information necessary for preparing installation drawings.

The design and procurement of each item of equipment is accomplished through the combined efforts of process engineers, equipment engineers, and purchasing agents. These efforts produce a series of documents that evolve, ultimately, into a complete, definitive procurement package. The individual documents are as follows:

- Functional Specifications
- Engineering Specifications
- Request For Quotation (RFQ)
- Request For Requisition (RFR)
- Purchase Order (PO)
- Procurement Status Report

These six documents serve as milestones for measuring performance of the procurement cycle for each item of equipment.

1.1.3.1 Process Control

The controls systems engineering effort includes all activities associated with developing the P&I diagram, designing process control loops and control panels, specifying valves and instrumentation, and preparing control wiring and pneumatic diagrams. An instrument equipment list was developed from the P&I diagrams and the schematic wiring diagram was expanded to show the interfaces between field instruments, panel instruments and the data collection system. The logic diagram was completed and was reviewed by the process group and issued.

Programming of the Modicon unit was initiated. The Modicon 584 PC is a solid-state device designed to perform logic, timing, sequencing and calculations for industrial control applications. It is a general purpose device that can be used as a direct replacement for relays or solid-state electronics in an industrial environment.

1.1.3.7 Other Equipment, Specialties

Key items addressed during this quarter were:

(a) The leak detector for the gas superheater was received with an incorrect pH control module. This has been corrected and the assembly is in check-out for satisfactory performance. The instrument will continuously sample the superheater flue gas and set off an alarm if a high level of HCl is detected. The detection method is to dissolve the stack gas in de-ionized water and test the solution with a chloride-sensitive electrode.

(b) A request for requisition has been issued for the silica agglomerator. This unit uses a helical coil of high tensile piano wire to scrape the edge of the pipe, knocking loose any silica deposits.

(c) The pyrolysis hydrogen compressor is now being refitted to meet electronic-grade purity specifications. This equipment rework constitutes the single largest specialty item.

(d) All sample conditioners are assembled and are in the process of being cleaned to meet electronic grade cleaning standards.

(e) The total complement of seven chlorosilane pump systems assembly was completed.

1.1.3.8 Data Collection System

The programming portion to be written by the Process Group has been completed, the documentation will be issued in the next quarter. The Computer Applications Group have some remaining work to complete the data storage and retrieval system.

The computerized data collection system for the 200 [illegible]ar silane-to silicon EPSDU plant will provide operational guidance and design data for the commercial facility. The basis of this system is the computer control system which is used by UCC-Linde in the control of Air Separation Plants.

The additions to the control system include the capability to store large amounts of data at varying time cycles, to input offline data, to do preliminary data reduction on a daily basis, and to incorporate chromatograph results into flow calculations. These additions provide a data collection system which fulfills the program requirements.

On-line data (scanivalve points and direct inputs) are collected at specified time intervals by the computer. The off-line data (analyses and manual readings) are manually entered through one of the peripheral devices. Information about the process can be obtained in either of two ways:

(1) Automatic readout in the form of a log, a daily report or a message,

or

(2) Operating personnel can request by typing manual instructions to the computer to display a group of process variables or an hourly average of key variables for the past 24 hour period.

A sample of the daily report (4 pages) is shown in Table II.

1.1.4 Installation Design, Specification, Subcontract

This design effort includes development of separate installation drawing packages for the site, civil, mechanical, and electrical specialties based on the engineering design effort and vendor-supplied information. Specification activity includes definition of specific requirements for performing all installation functions. Subcontracting includes the preparation of bid packages, evaluation of quotes, sub-contractor selection and contract negotiation.

TABLE II - DAILY OPERATIONS REPORT (PAGE 1 of 4)

EXPERIMENTAL PROCESS DEVELOPMENT UNIT

SILANE-TO-SILICON PROCESS

DAILY OPERATIONS REPORT
DATE: 7 6 81
TIME: 8 33 18

OVERALL MASS FLOW - SILANE FACILITY

CONSUMED(LB/HR)	PRODUCT(LB/HR)	WASTE(LB/HR)	RECYCLE(LB/HR)
H2 = 1000.0	SIH4= 1000.0	H2 = 1000.0	DCS = 1000.0
TCS = 1000.0		SIH4= 1000.0	TCS = 1000.0
STC = 1000.0		HCL = 1000.0	STC = 1000.0
SI = 1000.0		MCS = 1000.0	
CU = 1000.0		DCS = 1000.0	
N2 = 1000.0		TCS = 1000.0	
		STC = 1000.0	
		SI = 1000.0	
		CU = 1000.0	
		N2 = 1000.0	

HYDROGENATION MASS FLOWS

CONSUMED(LB/HR)	PRODUCT(LB/HR)	WASTE(LB/HR)	RECYCLE(LB/HR)
H2 = 1000.0	H2 = 1000.0	H2 = 1000.0	H2 = 1000.0
HCL = 1000.0	HCL = 1000.0	HCL = 1000.0	HCL = 1000.0
DCS = 1000.0	MCS = 1000.0	DCS = 1000.0	DCS = 1000.0
TCS = 1000.0	DCS = 1000.0	TCS = 1000.0	TCS = 1000.0
STC = 1000.0	TCS = 1000.0	STC = 1000.0	STC = 1000.0
SI = 1000.0	STC = 1000.0	SI = 1000.0	N2 = 1000.0
CU = 1000.0	N2 = 1000.0	CU = 1000.0	
N2 = 1000.0		N2 = 1000.0	

DISTILLATION MASS FLOWS

CONSUMED(LB/HR)	PRODUCT(LB/HR)	WASTE(LB/HR)	RECYCLE(LB/HR)
H2 = 1000.0	SIH4= 1000.0	H2 = 1000.0	DCS = 1000.0
HCL = 1000.0		SIH4= 1000.0	TCS = 1000.0
MCS = 1000.0		HCL = 1000.0	STC = 1000.0
DCS = 1000.0		MCS = 1000.0	
TCS = 1000.0		DCS = 1000.0	
STC = 1000.0		N2 = 1000.0	
N2 = 1000.0			

PYROLYSIS/MELTING MASS FLOWS

CONSUMED(LB/HR)	PRODUCT(LB/HR)	WASTE(LB/HR)	RECYCLE(LB/HR)
SIH4= 1000.0	SI = 1000.0	H2 = 1000.0	H2 = 1000.0
		SIH4= 1000.0	
		SI = 1000.0	

TABLE II - DAILY OPERATIONS REPORT (PAGE 2 of 4)

UTILITIES/RAW MATERIALS REPORT

UTILITIES USAGE

C WATER	= 1000.0 GPM	OUT =	1000.0 DEG F
		RET =	1000.0 DEG F
THERMINOL	= 1000.0 GPM	HOT =	1000.0 DEG F
		RET =	1000.0 DEG F
REFRIGERNT	= 1000.0 GPM	OUT =	1000.0 DEG F
		RET =	1000.0 DEG F

NAT GAS	= 1000.0 ACF	DATE: 10 10 TO 10 10
ELECTRICAL	= 1000.0 KWH	DATE: 10 10 TO 10 10
NITROGEN	= 1000.0 ACF	DATE: 10 10 TO 10 10

RAW MATERIALS- ON HAND

STC TANK	= 1000.0 GAL
MG SI BIN	= 1000.0 LBS
DRIOX M2	= 1000.0 ACF

HYDROGENATION DETAILED REPORT

ATOMIC MASS FLOW

LBS IN		LBS OUT	
H	= 1000.0	H	= 1000.0
CL	= 1000.0	CL	= 1000.0
SI	= 1000.0	SI	= 1000.0

HEAT DUTY REPORT

HT EXCHANGER	DUTY BTU/HR
VAPORIZOR	= 1000.0
SUPERHEATR	= 1000.0
Q CONDENSR	= 1000.0

REACTOR

TEMP	= 1000.0 DEG F
PRESSURE	= 1000.0 PSIA
% CU	= 1000.0
H2/SIC	= 1000.0
CONVERSION	= 1000.0 LBS
PART SIZE	= 1000.0 MICROM

W SETTLER

TEMP	= 1000.0 DEG F
PRESSURE	= 1000.0 PSIA
RECYCLE TO	= 1000.0 LBS/HR
RECYCLE FR	= 1000.0 LBS/HR
DUMPED	= 1000.0 LBS

Q CONDENSR

DELTA P	= 1000.0 PSI
WASH FLOW	= 1000.0 LBS/HR

TCS TANK

LEVEL	= 1000.0 INCHES
DELTA P	= 1000.0 PSI

TABLE II - DAILY OPERATIONS REPORT (PAGE 3 of 4)

DISTILLATION AREA DETAILED REPORT

STRIPPER COLUMN

TOTAL FEED (LBS/HR)		DISTILLATE (LBS/HR)		BOTTOMS (LBS/HR)	
H2 =	1000.0	H2 =	1000.0	H2 =	1000.0
SIH4=	1000.0	SIH4=	1000.0	SIH4=	1000.0
HCL =	1000.0	HCL =	1000.0	HCL =	1000.0
MCS =	1000.0	MCS =	1000.0	MCS =	1000.0
DCS =	1000.0	DCS =	1000.0	DCS =	1000.0
TCS =	1000.0	TCS =	1000.0	TCS =	1000.0
STC =	1000.0	STC =	1000.0	STC =	1000.0
N2 =	1000.0	N2 =	1000.0	N2 =	1000.0

REFLUX RAT=	1000.0	PRESSURE	= 1000.0 PSIA		
CONDENSER =	1000.0 BTU/HR	TEMP	= 1000.0 DEG F		
REBOILER =	1000.0 BTU/HR	TEMP	= 1000.0 DEG F		
SEPARATION=	1000.0	TEMP	= 1000.0 DEG F		

TCS COLUMN

TOTAL FEED (LBS/HR)		DISTILLATE (LBS/HR)		BOTTOMS (LBS/HR)	
SIH4=	1000.0	SIH4=	1000.0	SIH4=	1000.0
HCL =	1000.0	HCL =	1000.0	HCL =	1000.0
MCS =	1000.0	MCS =	1000.0	MCS =	1000.0
DCS =	1000.0	DCS =	1000.0	DCS =	1000.0
TCS =	1000.0	TCS =	1000.0	TCS =	1000.0
STC =	1000.0	STC =	1000.0	STC =	1000.0

REFLUX RAT=	1000.0	PRESSURE	= 1000.0 PSIA		
CONDENSER =	1000.0 BTU/HR	TEMP	= 1000.0 DEG F		
REBOILER =	1000.0 BTU/HR	TEMP	= 1000.0 DEG F		
SEPARATION=	1000.0	TEMP	= 1000.0 DEG F		

DCS COLUMN

TOTAL FEED (LBS/HR)		DISTILLATE (LBS/HR)		BOTTOMS (LBS/HR)	
SIH4=	1000.0	SIH4=	1000.0	SIH4=	1000.0
HCL =	1000.0	HCL =	1000.0	HCL =	1000.0
MCS =	1000.0	MCS =	1000.0	MCS =	1000.0
DCS =	1000.0	DCS =	1000.0	DCS =	1000.0
TCS =	1000.0	TCS =	1000.0	TCS =	1000.0
STC =	1000.0	STC =	1000.0	STC =	1000.0

REFLUX RAT=	1000.0	PRESSURE	= 1000.0 PSIA		
CONDENSER =	1000.0 BTU/HR	TEMP	= 1000.0 DEG F		
REBOILER =	1000.0 BTU/HR	TEMP	= 1000.0 DEG F		
SEPARATION=	1000.0	TEMP	= 1000.0 DEG F		

SIH4 COLUMN

TOTAL FEED (LBS/HR)		DISTILLATE (LBS/HR)		BOTTOMS (LBS/HR)	
SIH4=	1000.0	SIH4=	1000.0	SIH4=	1000.0
HCL =	1000.0	HCL =	1000.0	HCL =	1000.0
MCS =	1000.0	MCS =	1000.0	MCS =	1000.0
DCS =	1000.0	DCS =	1000.0	DCS =	1000.0
TCS =	1000.0	TCS =	1000.0	TCS =	1000.0
STC =	1000.0	STC =	1000.0	STC =	1000.0

REFLUX RAT=	1000.0	PRESSURE	= 1000.0 PSIA		
CONDENSER =	1000.0 BTU/HR	TEMP	= 1000.0 DEG F		
REBOILER =	1000.0 BTU/HR	TEMP	= 1000.0 DEG F		
SEPARATION=	1000.0	TEMP	= 1000.0 DEG F		

TCS REDISTRIBUTION REACTOR

LBS/HR IN		LBS/HR OUT	
SIH4=	1000.0	SIH4=	1000.0
HCL =	1000.0	HCL =	1000.0
MCS =	1000.0	MCS =	1000.0
DCS =	1000.0	DCS =	1000.0
TCS =	1000.0	TCS =	1000.0
STC =	1000.0	STC =	1000.0

TOTAL	=	1000.0 LBS/HR
TEMP	=	1000.0 DEG F
PRESSURE	=	1000.0 PSIA
CLIH	=	1000.0
CONVERSION=		1000.0 LBS

DCS REDISTRIBUTION REACTOR

LBS/HR IN		LBS/HR OUT	
SIH4=	1000.0	SIH4=	1000.0
HCL =	1000.0	HCL =	1000.0
MCS =	1000.0	MCS =	1000.0
DCS =	1000.0	DCS =	1000.0
TCS =	1000.0	TCS =	1000.0
STC =	1000.0	STC =	1000.0

TOTAL	=	1000.0 LBS/HR
TEMP	=	1000.0 DEG F
PRESSURE	=	1000.0 PSIA
CLIH	=	1000.0
CONVERSION=		1000.0 LBS

TABLE II - DAILY OPERATIONS REPORT (PAGE 4 of 4)

DATE: 7 6 81
TIME: 8 33 18

PYROLYSIS/MELTING DETAILED REPORT

REACTOR

LBS IN		LBS OUT	
SIH4=	1000.0	SIH4=	1000.0
		H2 =	1000.0
		SI =	1000.0

TEMP	= 1000.0	DEG F
PRESSURE	= 1000.0	PSIA
ELECTRICAL	= 1000.0	KW
ARGON	= 1000.0	ACF

MELTERS

LBS #1		LBS #2	
SI =	1000.0	SI =	1000.0

TEMP	#1 =	1000.0	DEG F	TEMP #2 =	1000.0 DEG F
PRESSURE	#1 =	1000.0	PSIA	PRESSURE #2 =	1000.0 PSIA
ELECTRICAL	#1 =	1000.0	KW	ELECTRICAL #2 =	1000.0 KW
ARGON	#1 =	1000.0	ACF	ARGON #2 =	1000.0 ACF

WASTE TREATMENT AREA DETAILED REPORT

WASTE BURNER #1

THROUGHPUT=	1000.0	LBS
TEMP	= 1000.0	DEG F
COMB AIR	= 1000.0	ACF
NAT GAS	= 1000.0	ACF

WASTE BURNER #2

THROUGHPUT=	1000.0	LBS
TEMP	= 1000.0	DEG F
COMB AIR	= 1000.0	ACF
NAT GAS	= 1000.0	ACF

WASTE BURNER #3

THROUGHPUT=	1000.0	LBS
TEMP	= 1000.0	DEG F
COMB AIR	= 1000.0	ACF
NAT GAS	= 1000.0	ACF

LIQUID BURNER

THROUGHPUT=	1000.0	LBS
TEMP	= 1000.0	DEG F
COMB AIR	= 1000.0	ACF
NAT GAS	= 1000.0	ACF

1.1.4.4 Mechanical Design, Specification & Materials and
1.1.4.5 Mechanical Drawings

The field bill of materials and the specification for cleaning chlorosilane piping was issued and included in the mechanical specification package. The balance of the piping components was ordered.

The completed specifications, 65 mechanical and 43 instrumentation drawings were reviewed during an Engineering Team meeting and released for bidding to five sub-contractors on April 24, 1981.

Construction drawings were compared to the gantry scale model as an additional design check.

1.1.4.6 Electrical Design, Specification & Materials and
1.1.4.7 Electrical Drawings

The electrical bid package was issued on June 26, 1981.

1.1.6 Pyrolysis/Melting System Design

Work in this area started in May and involves preparing equipment and installation designs for EPSDU pyrolysis and melting systems. The information generated from the PDU experiments (WBS 1.1.1.3) and pyrolysis process design (WBS 1.1.1.4) serve as a basis for this activity.

The first activity under this work item consists of preparing a detailed P&I diagram for the integrated free-space reactor/shotter arrangement. Following the completion of the P&I diagram and Instrument List, RFQ's for the various equipment items will be prepared in order to obtain quotations from vendors.

1.2 EQUIPMENT FABRICATION/DELIVERY

This report item includes all in-house and outside activities associated with fabrication, delivery, and vendor coordination for all items of equipment.

A total of 224 purchase orders have been issued-to-date to supply approximately 3000 items ranging from large distillation columns to small valves. The total cost of items purchased is 1.8 million dollars and over 90% of the equipment has been received.

1.2.1 Process Control and Data Collection System

1.2.1.1 Field Instruments and Controls

Purchase orders were issued for a further assortment of 80 valves and flow indicators.

1.2.1.2 Panels and Panel Instruments

Purchase orders for 238 items were placed in this quarter.

1.2.1.4 Data Collection Equipment

A purchase order for 23 computer components was issued.

1.2.8 Procurement Support

This task includes the Procurement Department effort necessary to initiate, monitor and control the purchase of equipment.

1.2.8.1 Purchasing, Expediting

Fabrication of two equipment items were completed but shipment was withheld due to the operating engineer's strike at the EPSDU job site. The MCC No. 1 (Westinghouse) and agglomerator (Von Dugan) will be held for delivery until the job site has equipment off-loading and handling capability once again. The updated procurement status report is shown as Appendix A.

1.2.8.2 Equipment Design and Inspection

A meeting was held at the EPSDU job site to review shop and field inspection procedures with JPL Q.A. personnel. UCC explained the method by which a piece of equipment is accepted. First, inspections are made to the

fabricators shop on a spot basis since we purchase from established suppliers who have been previously qualified by supplying other equipment to UCC. Reliance is placed on the suppliers' past record.

The design and ordering a specific piece of equipment involves many individuals:

- Mechanical Designer/Draftsman
- Process Engineer
- Instrumentation Engineer
- Specification Writer
- Purchasing Agent

The mechanical designer/draftsman designs the equipment [illegible]llation with the concurrence of the process engineer and other team members. The drawings and specifications are issued for bids, a qualified bidder is selected and a purchase order is issued.

Upon receipt of the equipment at the job site, the equipment is inspected to establish that it conforms to the drawings i.e. dimensionally correct, accurate nozzle locations, correct materials and finish. The process engineer also inspects to assure that the delivered equipment meets the intent of the original design concept and is acceptable -- thus the design loop is completed. If a piece of equipment fails this inspection procedure, corrective action is sought from the vendor. This can take a number of ways; repair in the field by available qualified personnel and costs are back charged, or the vendor sends their own personnel to make field repairs, or the equipment is returned at their expense for repair at their shop.

The following list of equipment was checked and reported in good condition except for a few minor points which will be corrected. This list does not necessarily include all equipment which has been inspected.

Equipment Inspected

Waste settler tank (421-04)
Pressure relief catch tank (451-06)
Quench condenser receiver (421-08)
Quench condenser (424-08)

DCS condenser (434-14)
STC storage tank (421-12)
Gas superheater furnace (429-04)
Hot oil heating furnace (46[illegible]16)
MC silicon bin (411-02)
Silica bin (451-08)
Waste settler tank (421-04)
Silica venturi (459-02)
Muriatic scrubber (459-04)
Emergency generator (643-02)
Dryout heater (464-06)
Crude TCS storage tank (421-10)
Muriatic tailing column (452-02)
Hydrogenation reactor (425-02)
Recycle hydrogen compressors (423-02 and -03)

In general, Figures 1 through 6 are photographs of major equipment items which have been received and some of which have not been set on their foundation pads.

The procurement of equipment and materials for this phase of EPSDU project is essentially complete.

1.2.6.4 Tonawanda Equipment Cleaning

A cleaning station was established and cleaning of equipment was started and will be completed in the third quarter. Items to be cleaned (valves, regulators, etc.) are sonically and chemically cleaned to exacting standards and are packaged in sealed plastic bags, which will not be opened until installation at EPSDU.

1.3 INSTALLATION AND CHECKOUT

This report item includes all effort associated with award of subcontracts, providing instructions to the on-going subcontract activities, monitoring subcontractor performance, and checkout activities to ensure proper installation.

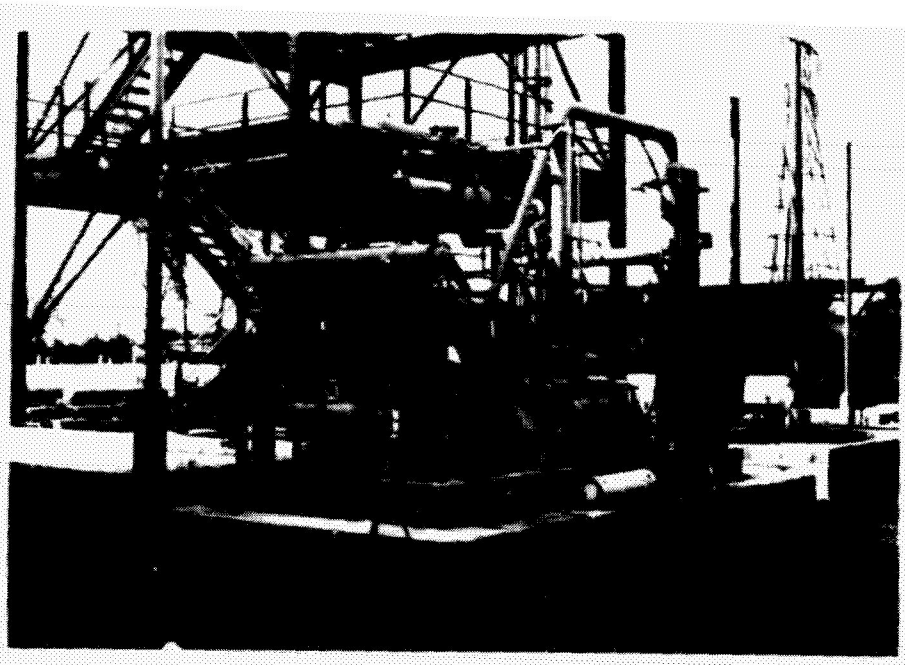


Figure 1.

Refrigeration Skid
Equip. No. 469-12

Figure 2.

Dichlorosilane Column
Equip. No. 432-06

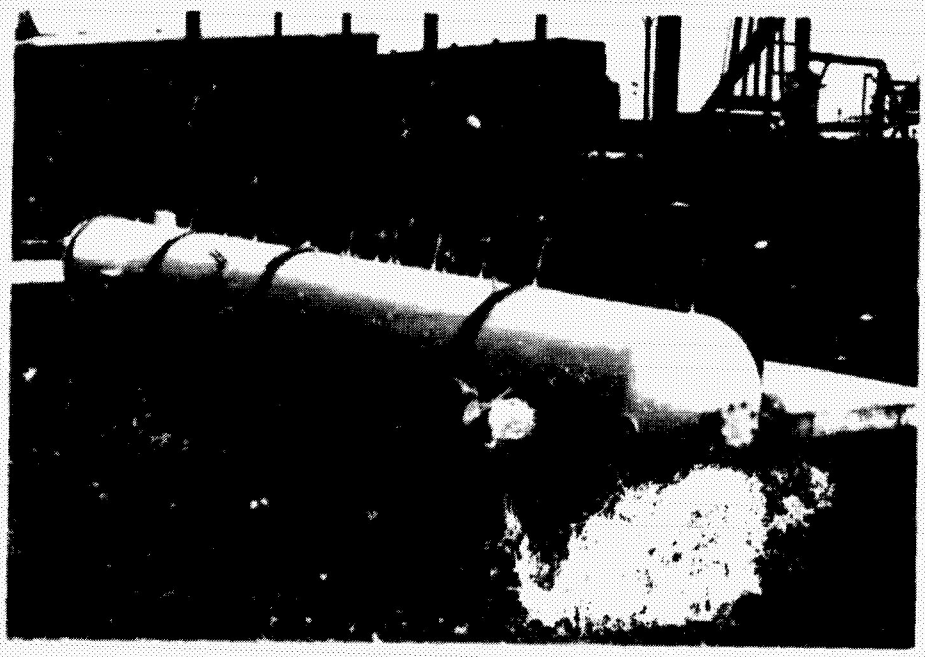


Figure 3.

Trichlorosilane Column
Equip. No. 432-04

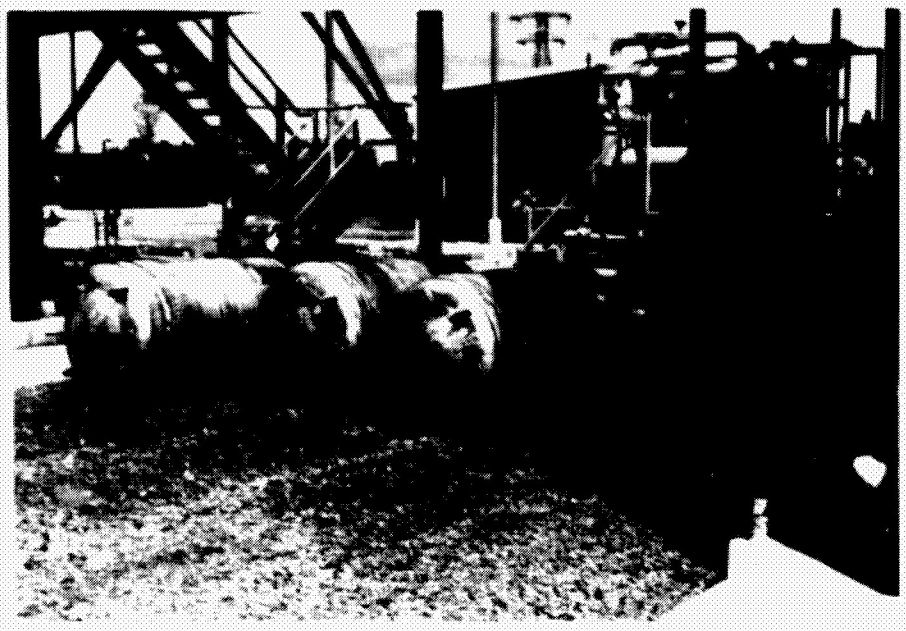


Figure 4.
Silane Storage Tanks

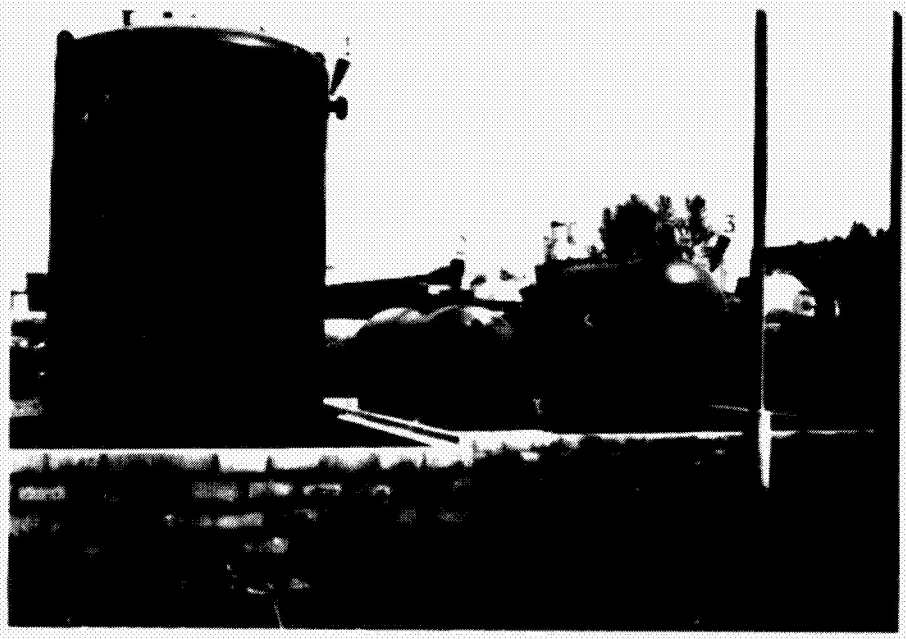


Figure 5.
(1) Caustic Tank
(2) Silicon Tetrachloride Tank
(3) Trichlorosilane Tank

Figure 6.
Super Heater and Therminol Furnace

1.3.1 Installation Subcontracts

This task includes the effort for all installation activities assigned to subcontractors and includes labor, materials, and day-to-day job supervision. Monthly reports are issued which include progress details, schedule and cost summaries.

The civil contract is complete except for repair to the primer on the gantry structure and some miscellaneous details. Calumet Industries, who have permanent personnel located at the adjacent Linde Gas Plant, have placed major equipment items on their foundations. The completion of this activity has been delayed due to a strike of the Operating Engineers – this will not cause a slippage for the plant construction plan since the award of the mechanical construction package has been delayed.

1.3.2 Installation Materials

Twenty-one purchase orders were issued for a total of 1234 items such as valves, gages, etc.

1.3.3 Installation Support

1.3.3.5 Procurement

A meeting was held at the East Chicago jobsite on May 13, 1981 with the five contractors bidding on the mechanical subcontract. Various questions on the drawings and specifications were resolved.

Mechanical subcontract bids were received on June 22, 1981 from the five contractors. Evaluation of bids and bid award have been indefinitely postponed pending JPL/UCC funding resolution.

Electrical subcontract bid packages were issued to four candidate contractors on June 26, 1981. Bids are due on July 31, 1981.

1.4 OPERATION

This work item includes all activities necessary to operate EPSDU to demonstrate operability, provide representative product samples, generate

performance data for economic assessment and equipment and system design data for a commercial facility.

1.4.1 Preparation

This ac ivity includes training of operating personnel, preparation of an operations manual and test plan.

1.4.1.1 Operations, Operating Manual

The operations manual will consist of six volumes:

I. Safety
II. Description
III. Operation
IV. Maintenance
V. Test Plan
VI. Quality Control Laboratory

A draft of the chemical safety section of the first volume has been written and is under review.

1.6 PROCESS SUPPORT R & D

The supporting R & D Program is separate from the mainstream design effort and includes all activities associated with analytical and experimental development of the free-space reactor, melting/consolidation system, fluid-bed reactor system, and quality control techniques and procedures. Information generated in this program will be used for the EPSDU effort and the commercial facility economic analysis.

1.6.2 Melting/Consolidation

The design and development effort necessary to obtain a reliable melter for EPSDU involves UCC and sub-contractor (Kayex) effort.

1.6.2.1 Melter System Subcontract

This effort involves establishing and managing the sub-contract and sub-contractor development, design, and fabrication efforts.

Kayex Corporation is developing the silicon melter system for EPSDU. The silicon consolidation scheme is based on melting the powder in a quartz crucible and dropping molten silicon shot from the crucible bottom into a cooling tower where the shot is solidified. The goal is to design and build a melting/consolidating system suitable for installation in the EPSDU.

The sub-contractor has made significant progress during the second quarter, having overcome minor engineering setbacks and schedule delays. Although behind the original program schedule, it is projected that Kayex will meet contractual items within the allowable budget.

The following log summarizes the significant runs made during the second quarter reporting period:

During the period from March through May 1981, 9 melt runs and 13 dry runs were made. Equipment problems were encountered and solved.

The pertinent details of the melt runs are listed:

- Melt Run Number 1 (3/4): Purpose - melt chunks, produce shot with 1 mm orifice, a 5.5 kg load, and no pressure difference. Results - a coil water blockage caused overheating and premature shut down; some silicon was melted, but no shot was produced.

- Melt Run Number 2 (3/10): Purpose - to melt and produce shot in a demonstration for JPL and Union Carbide with a 1 mm orifice, a 3.9 kg load, and no pressure difference. Results - nearly complete melting was achieved, but no shot was produced.

- Melt Run Number 3 (3/20): Purpose - to melt and shot silicon with a 2 mm orifice while utilizing the design changes of Dry Heat Run Number 8 as well as having the coil turns spaced more closely at the base, loading with finely ground chunks to the top of the crucible (6.1 kg load) and being capable of applying a pressure difference to the melt. Results - the chunks bridged at

the top, but melted at the bottom, shot was produced without applying a pressure difference, the base of the crucible failed, producing blobs of molten silicon shot, and the collection tube cracked.

- Melt Run No. 4 (4/15): Purpose - to produce shot using a crucible with a round bottom and a 2 mm drawn-down orifice, using three kilograms of silicon and using a lower hot zone height in the coil. Results - no shot was produced despite applying 6 psi to the melt.

- Melt Run No. 5 (4/16): Purpose - to produce shot using a round-bottom crucible with a 2 mm drawn-down orifice, using a hot zone located 3/4 inch higher in the coil than the last run and using four kilograms of silicon. Results - the crucible shook in the susceptor, and full power was maintained for 25 minutes until the nozzle failed and silicon poured down into the collection tube. The susceptor cracked during cooling.

- Melt Run Number 6 (5/1): Purpose - to produce shot using a capillary tubing nozzle with a 2 to 2-1/2 mm orifice and using 3.8 kg of silicon. Results - shot was produced, but the diameter was too large to freeze in the drop tube, causing a molten pile in the collection tube.

- Melt Run Number 7 (5/7): Purpose - to produce shot using a 1.3 mm orifice in a capillary tubing nozzle with 3.65 kg of silicon. Results - the best shot of all runs was produced, although a considerable molten pile formed in the collection tube. A crack in the nozzle forced early shutdown.

- Melt Run Number 8 (5/14): Purpose - to produce shot using a 0.94 mm orifice and 2.42 kg of silicon chunks. Results - shotting was maintained for 1/2 hour and a 1.5 psi pressure difference was found to be optimal. A throughput of 1.9 kg was obtained and quality of shot was good.

- Melt Run Number 9 (5/19): Purpose - to produce shot using a 0.74 mm orifice and 2.7 kg of silicon. Results - although the quartz collection tube cracked causing drop tube pressure to drop to zero, 3.45 kg of silicon throughput (91%) was achieved over 44 minutes and considerable quantity of good shot was produced.

Kayex progress reports to UCC are out of phase by one month with the UCC reporting to JPL. In order to bring the reader up-to-date, a general report of achievements in June is also included. Two additional successful runs were made in June using chunk silicon and orifice sizes 0.56 and 0.66 mm. Also the powder transport system demonstrated that free-space reactor powder can be pneumatically transported to a height of 25 feet through a 2-inch diameter pipe. A subsequent run, also demonstrated that powder can be melted in a quartz crucible.

A detailed quarterly review was held at Kayex on June 26th. It was agreed that Kayex will deliver all contractual items including:

- Detailed Operating Manual,
- Detailed Technology Development Report which will include experimental results and a technical assessment,
- Functional Design Report including up-to-date drawings.

1.6.3 Fluid-Bed Development

This development program includes all analytical, experimental, and design effort associated with developing a fluid-bed reactor as an alternative or backup system to the free-space reactor.

1.6.3.4 Fluid-Bed Pyrolysis (PDU)

This work item consists of all efforts associated with the design, fabrication, and testing of an experimental unit to establish design data for an EPSDU-scale system.

The following log summarizes the fluid-bed runs (using hydrogen as the fluidizing gas) which were made during April and May before the test plan was stopped because of funding restrictions.

April 1981

- Run Number 1: Purpose - to test electrical band heaters. Results - heater bands overheated due to an incorrect placement of the control thermocouple.

- Run Number 2: Purpose - to repeat Run Number 1 with the control thermocouple relocated and determine bed temperature profiles. Arc heating was also applied to increase bed temperature heat-up. Results - sintering of particles occurred due to the localized high temperature between the arc heating electrodes.

May 1981

- Run Number 3: Purpose - to test band heaters directly clamped to the reactor wall. Results - a bed temperature of 475°C was achieved in the short duration run.

- Run Number 4: Purpose - to test heating response with power applied to the arc heating electrodes. Results - arc heating raised the upper bed temperature from 545°C to 615°C in 1-1/2 hours. Again, some silicon particle sintering took place.

- Run Number 5: Purpose - to test the introduction of silane to the hydrogen fluidizing gas. Results - it was demonstrated that with a concentration of 10% silane feed, a conversion of 85% was achieved.

- Run Number 6: Purpose - to increase silane feed (fluid bed was kept hot overnight after previous run). Results - silane feed rate was increased to 21% with a corresponding increase in bed temperature to 685°C and a silane-to-silicon conversion rate of up to 99.7% was achieved.

Samples of fluid bed particles were submitted to the materials engineering laboratory to check appearance using a scanning electron microscope.

Figures 7 and 8 show the low and high magnification views (50X and 5000X respectively) of Sample No. 1 (silicon particles after Run 4, Series A). These particles are typical for those unexposed to silane, have vivid edges with high definition of the surface characteristics. The high magnification SEM shows evidence of slight surface debris.

In contrast, Figure 9 and 10 show well rounded particles with a substantial modular silicon surface deposition. These views represent particles from Sample No. 2 (after Run 6, Series A, silane addition).

FIGURE 7. Silicon Particles, Sample No. 1 - Low Magnification (50X)

FIGURE 8. Silicon Particles, Sample No. 1 - High Magnification (5000X)

FIGURE 9. Silicon Particles, Sample No. 2 - Low Magnification (50X)

FIGURE 10. Silicon Particles, Sample No. 2 - High Magnification (5000X)

FIGURE 11. Silicon Particles,
Sample No. 2 - After Etching (200X)

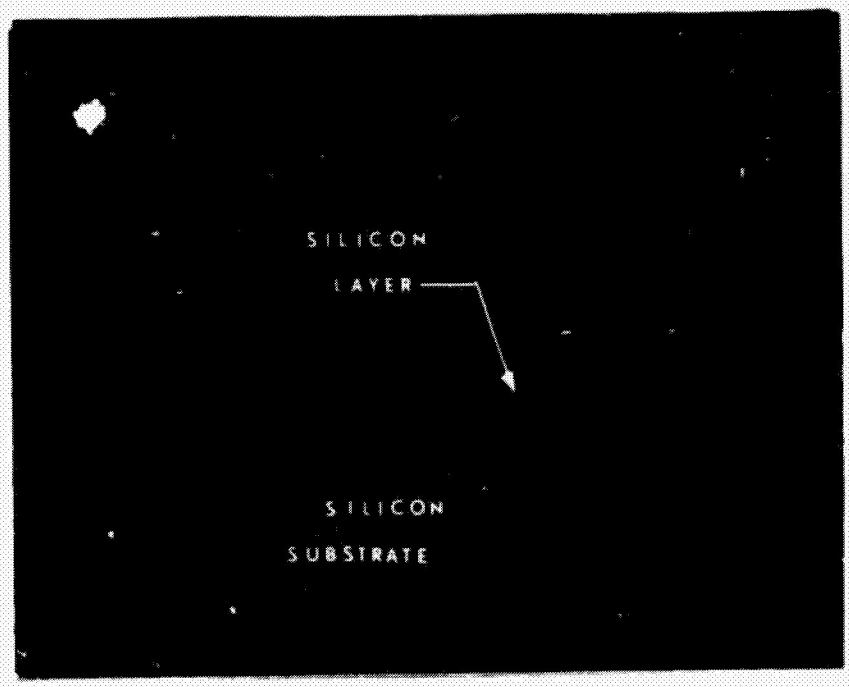


FIGURE 12. - Silicon Particles,
Sample No. 2 - After Etching (1000X)

Figure 11 is an optical photomicrograph showing the cross-sectional views of random silicon particles from Sample No. 2 (silicon particles after Run 6, Series A, silane addition). After the cross-sections were metallographically prepared and etched, an effort was made to determine the thickness and characteristics of the deposited silicon layer which was the result of the silicon/silane reaction. The particles shown in Figure 11 exhibit a relatively homogeneous silicon layer with respect to deposition rate (thickness). Several measurements were taken on the silicon layers of these particles. The thickness of the deposited silicon layer ranged from approximately .00019" to .00023". The original silicon particle size seemed to have little, if any, effect on the deposition rate/thickness of the silicon layer.

Figure 12 is a high magnification view (1000X) of Sample No. 2. This cross-sectional view of a random particle is typical of the uniform silicon layer found in this sample.

The initial start-up runs were extremely encouraging. Although, the fluid-bed program is on hold as of May 15, 1981 due to funding recision, and the equipment has been "moth-balled", it appears to offer great potential for converting silane to silicon.

1.7 MANAGEMENT AND DELIVERABLES

This report item includes all activities associated with managing the program and insuring that all deliverables are made in accordance with the program requirements.

Balance of Program Activities

The estimate-to-complete for the remaining EPSDU effort through 1983 was transmitted to JPL in the first quarter and there were many questions which required detailed cost back-up. The fact finding review was concluded at the seventh bimonthly review held at Tonawanda on May 5th to 8th. The fiscal year 1981 budget was reduced and work was discontinued in the pyrolysis systems engineering area (1.1.6), and the fluid-bed development (1.6.3). During May, the planned fiscal year '81 activities were restructured to meet the budget constraints. All project costs including committed costs were reviewed and a new Performance Measurement System (PMS) was issued dated

May 29, 1981. This updated PMS covers projected expenditures and work schedules for the balance of the Fy 1981 (through Oct 31, 1981). The pyrolysis systems engineering work (1.1.6) was reactivated in the newly structured program.

It had been planned to award the mechanical and electrical sub-contracts for the EPSDU plant in the third quarter, however, this has been placed on hold until future funding is known. This will result in a slippage of the start-up of EPSDU facility.

JPL/UCC Bimonthly Meeting

The seventh bimonthly review was held from the 5th to 8th of May, 1981 at Tonawanda. Items discussed included areas where expenditures could be postponed, the Fy 1981 budget, possible ceiling for funding in Fy 1982 and review of equipment costs already purchased. JPL witnessed the first introduction of silane to the fluid-bed PDU - the test was successful and is documented in other sections of this report. JPL also visited Kayex on May 7th and witnessed a moderately successful shot run made with a 1.3 mm sized orifice.

Deliverables

The monthly technical progress reports were issued along with the monthly financial and management reports.

The fourth quarter 1980 and the first quarter 1981 progress reports were issued.

Major Milestones

The major milestones reached this quarter are presented in Table III.

TABLE III MAJOR MILESTONES REACHED

WBS NO.	MILESTONE	DESCRIPTION OF MAJOR MILESTONE
1.1.1.2	C	Installation design review complete. Meeting minutes issued.
1.1.1.4	A	Process design package issued.
1...4.4	E	Mechanical/Piping package issued for bids.
1.1.4.5	F	Drawings issued for bid package.
1.1.4.6	G	Electrical package issued for bids.
1.1.4.7	H	Electrical drawings issued for bid package.
1.1.6.1	O	Control System Design P&I package started.
1.2.2.3	H	Final invoice payment.
1.2.3.2	H	Final invoice payment.
1.2.3.3	H	Final invoice payment.
1.2.4.1	H	Final invoice payment.
1.2.4.2	G	All equipment received
1.2.4.3	G	All equipment received.
1.2.4.4	G H	All equipment received. Final invoice payment.
1.2.4.5	H	Final invoice payment.
1.2.4.7	G H	All equipment received. Final invoice payment.
1.2.5.1	H	Final invoice payment.
1.2.5.2	H	Final invoice payment
1.2.5.3	H	Final invoice payment.
1.2.5.4	H	Final invoice payment.
1.2.5.6	G H	All equipment received. Final invoice payment.
1.2.8.2	E F	Equipment inspection report issued. Specialty items delivered to site.
1.3.1.2	K	Final invoice payment.

TABLE III MAJOR MILESTONES REACHED (continued)

WBS NO.	MILESTONE	DESCRIPTION OF MAJOR MILESTONE
1.4.1.1	O	Operating manual started.
1.6.3.4.2	E	PDU system checkout completed.
1.6.3.4.3	P	Start-up with hydrogen completed.
	Q	"Arc discharge" heating of silicon bed completed.
1.7.3	R	Monthly Financial and Management Reports
	S	and Progress Reports issued.
	T	

SECTION III. CONCLUSIONS

Significant highlights and conclusions are presented according to the relevant WBS numbers.

1.1 DESIGN/PROCUREMENT

1.1.1 Process Design

- Mechanical design bid package was issued April 24, 1981.
- Mechanical design bids were received on June 22, 1981 and have been reviewed. However, the award of the sub-contract has been delayed until funding issues have been resolved.
- Electrical design bid package was issued on schedule, June 26, 1981.
- The pyrolysis/consolidation process design package was completed and issued in June.

1.1.2 Facility Design

- The completion of fabricating the gantry and facility scale models has been delayed due to the model shop heavy workload.

1.1.3 Equipment Design, Specification, Procurement

- Software for the data collection system is in place which allows disc storage of raw operating data and ability to produce a daily report of process performance.
- Assembly of all sample conditioners was completed.

1.1.4 Installation Design, Specification, Subcontract

- The field bill of materials and specification were issued and included in the mechanical design specification package.

1.1.6 Pyrolysis/Melting System

- The design effort, temporarily delayed, was reactivated in May and will be completed by R&D personnel. The P&I diagrams are being prepared.

1.2 EQUIPMENT FABRICATION/DELIVERY

- Ninety percent of the equipment has been received.
- Equipment received at the EPSDU site is entered in a materials receiving log and identification tags are attached to equipment items in excess of $1000.

1.3 INSTALLATION AND CHECKOUT

- Award of mechanical contract is delayed.
- Operating engineers at EPSDU site are on strike and placement of equipment is delayed.

1.4 OPERATION

- Draft of chemical safety section for the first of six volumes has been written.
- Equipment delivered to the EPSDU site has been inspected.

1.6 PROCESS SUPPORT R&D

1.6.2 Melting/Consolidation

- Kayex have demonstrated the system to varying degrees by melting silicon chunks, producing shot, stopping and starting shot by differential pressure and pneumatically transporting free-space reactor powder in a 2-inch diameter pipe through a vertical height of 25 feet.

1.6.3 Fluid-Bed Development

- The fluid-bed PDU was started up successfully and operated with silane feed concentrations up to 21%.
- The PDU was shut down due to budget constraints.

SECTION IV. PROJECTED QUARTERLY ACTIVITIES

1.1 EPSDU DESIGN/PROCUREMENT

1.1.1 Process Design

- A safety review of the pressure relief system design will be conducted.

1.1.2 Facility Design

- Gantry scale model will be corrected.
- Facility scale model will continue.

1.1.3 Equipment Design, Specification, Procurement

- Draft of programming description to produce the daily progress report will be issued.

1.1.4 Installation Design, Specification, Subcontract

- Final drawing and specification changes for the mechanical and electrical packages will be issued.
- Mechanical and electrical subcontracts will be awarded if funding is available.

1.1.6 Pyrolysis/Melting System Design

- Preliminary P&I diagram for the free-space reactor will be prepared.
- Preparation of RFQ's for major equipment in the pyrolysis section will start.

1.2 EQUIPMENT FABRICATION, DELIVERY

- Balance of equipment will be delivered to EPSDU site.
- Quality Control trailer will be delivered.
- Equipment cleaning will continue.

1.3 INSTALLATION & CHECKOUT

- Equipment received will be inspected.
- Mechanical and electrical installation may begin.

1.4 OPERATION

- Writing of the operating manual will continue.
- Electric power will be connected to the EPSDU site in July.

1.5 COMMERCIAL PROCESS ECONOMIC ANALYSIS

- No activity planned.

1.6 PROCE[illegible] .GRT R&D

1.6.2 Me[illegible] Consolidation

- Powder melting/shotting experiments will continue.
- Preparation of final report will start.

1.7 MANAGEMENT AND DELIVERABLES

- Monthly financial and management reports will be issued.
- Monthly technical reports will be issued.
- Second quarterly progress report (Apr - Jun 1981) will be issued.
- Deliverable documents based on the PMS will be issued.

APPENDIX A

EQUIPMENT PROCUREMENT STATUS

JUNE 1981

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIP-MENT REC'D
453-04-05 Waste Gas Induction Blower	50001	✓	✓	✓	✓	✓	✓	✓
453-02 Agglomeration Blower	50002	✓	✓	✓	✓	✓	✓	✓
	50003							
	50004							
426-02 Quench Contactor Pump	50005	✓	✓	✓	✓	✓	✓	✓
	50006							
	50007							
	50008							
	50009							
423-02, 03 Recycle H_2 Compressor	50010	✓	✓	✓	✓	✓	✓	✓
443-02 Pyrolysis H_2 Compressor	50011	✓	✓	✓	✓	✓	✓	
466-02 Hot Oil Pump	50012	✓	✓	✓	✓	✓	✓	✓
466-04, 05 Cooling Water Pump	50013	✓	✓	✓	✓	✓	✓	✓
424-02 Quench Condenser	50014	✓	✓	✓	✓	✓	✓	✓
424-04 434-06, 10 Reboilers	50015	✓	✓	✓	✓	✓	✓	✓

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	CERTIFIED DWG REC'D	EQUIP-MENT REC'D
434-02 Stripper Condenser	S0016	✓	✓	✓	✓	✓	✓	✓
421-12, 16 441-06 Tanks	S0017	✓	✓	✓	✓	✓	✓	✓
464-02, 04 Ventilation Heat Exchaners	S0018							
434-08, 14, 18 Column Condensers	S0019	✓	✓	✓	✓	✓	✓	✓
	S0020							
	S0021							
434-12, 16, 24 434-02 Coolers	S0022	✓	✓	✓	✓	✓	✓	✓
	S0023							
	S0024							
	S0025							
	S0026							
	S0027							
434-26 Refrig. Heating Coil	S0028	✓	✓	✓	✓	✓		✓
	S0029							
	S0030							

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	CERTIFIED DWG REC'D	EQUIP-MENT REC'D
	50031							
	50032							
411-02, 441-04 461-08 Bins	50033	✓	✓	✓	✓	✓	✓	✓
	50034							
421-02,04,06,08,10,14,18 451-04,06 Tanks	50035	✓	✓	✓	✓	✓	✓	✓
	50036							
	50037							
	50038							
	50039							
431-04, 06, 08, 10 435-02, 04 Tanks & Reactors	50040	✓	✓	✓	✓	✓	✓	✓
	50041							
	50042							
	50043							
	50044							
	50045							

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	CERTIFIED DWG REC'D	EQUIP-MENT REC'D
	50046							
	50047							
	50048							
	50049							
	50050							
	50051							
	50052							
	50053							
	50054							
461-02 Hot Oil Expansion Tank	50055	✓	✓	✓	✓	✓	✓	✓
425-02 Hydrogenation Reactor	50056	✓	✓	✓	✓	✓	✓	✓
445-02 Quartz Liner	50057							
	50058							
445-02 Pyrolysis Reactor and Hopper	50059							
417-02 457-04, 06 Filters	50060	✓	✓	✓	✓	✓	✓	✓

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	CERTIFIED DWG REC'D	EQUIP-MENT REC'D
427-02 Crude TCS Filter	50061	✓	✓	✓	✓	✓	✓	✓
437-02 Silane Ultra Filter	50062	✓	✓	✓	✓	✓	✓	✓
	50063							
	50064							
	50065							
	50066							
448-08, 10 Loading Scales	50067							
	50068							
448-04 Boule Cart	50069							
448-14 Boule Scale	50070							
	50071							
	50072							
458-04 Silica Drum Packer	50073	✓	✓	✓	✓	✓	✓	✓
	50074							

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	CERTIFIED DWG REC'D	EQUIP-MENT REC'D
459-02, 04 Venturi and Scrubber	50075	✓	✓	✓	✓	✓	✓	✓
429-04 Superheater	50076	✓	✓	✓	✓	✓	✓	✓
	50077							
	50078							
	50079							
	50080							
	50081							
	50082							
459-08, 10, 12, 14 Waste Burners	50083	✓	✓	✓	✓	✓		✓
	50084							
454-04 Silica Agglomerator	50085	✓	✓	✓	✓	✓	✓	
469-02 Cooling Tower	50086	✓	✓	✓	✓	✓	✓	✓
469-06 Cooling Tower Treatment	50087	✓	✓	✓	✓	✓	✓	✓
469-12 Refrigeration System	50088	✓	✓	✓	✓	✓	✓	✓

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	CERTIFIED DWG RCVD	EQUIPMENT RECVD
469-13 Therminol Heater	50089	✓	✓	✓	✓	✓	✓	✓
452-02 Muriatic Tailing Column	50090	✓	✓	✓	✓	✓		✓
456-08 Tailing Column Pump	50091	✓	✓	✓	✓	✓	✓	✓
469-14 Instrument Air Package	50092	✓	✓	✓	✓	✓	✓	✓
642-02 MCC	50093	✓	✓	✓	✓	✓		✓
631-02 Transformer	50094	✓	✓	✓	✓	✓	✓	✓
	50095							
365-02 Quality Control Trailer	50096	✓	✓	✓	✓	✓		
	50097							
411-08 TL Argon Tank	50098							
461-04, 06 Fuel Oil Storage Tank	50099	✓	✓	✓	✓	✓		✓
	50100							
	50101							
643 Emergency Generator	50102	✓	✓	✓	✓	✓		✓

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	CERTIFIED DWG REC'D	EQUIP-MENT REC'D
463-06, 08 Ventilation Blower	50103							
	50104							
426-06, 07 STC Pumps	50105	✓	✓	✓	✓	✓	✓	
	50106							
For 432-08 Internals for Silane Column	50107	✓	✓	✓	✓	✓	✓	✓
Chlorosilane Analysis	50108	✓	✓	✓	✓	✓		
UV Spectrophotometer	50109	✓	✓	✓	✓	✓		✓
Elemental Analysis	50110	✓	✓	✓	✓	✓		✓
Silicon Melting Furnace	50111	✓	✓	✓	✓	✓		✓
432-02 Stripper Column	50112	✓	✓	✓	✓	✓		✓
432-04 TCS Column	50113	✓	✓	✓	✓	✓		✓
432-06 DCS Column	50114	✓	✓	✓	✓	✓		✓
459-16 Agitator	50115	✓	✓	✓	✓	✓	✓	✓
429-02 Quench & Solids Removal Contractor	50116	✓	✓	✓	✓	✓	✓	✓

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	CERTIFIED DWG REC'D	EQUIP-MENT REC'D
	50117							
	50118							
466-06, 07 Fuel Oil Pumps	50119	✓	✓	✓	✓	✓	✓	✓
	50120							
	50121							
462-08 Silane Column	50122	✓	✓	✓	✓	✓		✓
	50123							
Field Instrumentation	50124	✓	✓	✓	✓	✓		✓
469-20 Instrument Air Dryer	50125	✓	✓	✓	✓	✓	✓	✓
428-04 Solids Conveyor	50126	✓	✓	✓	✓	✓	✓	✓
	50127							
	50128							
464-06 Thaw Heater	50129	✓	✓	✓	✓	✓	✓	✓
Program Controller	50130	✓	✓	✓	✓	✓		

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	CERTIFIED DWG REC'D	EQUIP-MENT REC'D
7 Haske[illegible]os	50131	✓	✓	✓	✓	✓		
Pressure Lubricators	50132	✓	✓	✓	✓	✓		✓
8 BP Valves & 7 Springs	50133	✓	✓	✓	✓	✓		✓
Main Instrument Panel "A"	50134	✓	✓	✓	✓			
Printer	50135	✓	✓	✓	✓	✓		
Computer	50136	✓	✓	✓	✓	✓		
Memorex Cartridges	50137	✓	✓	✓	✓	✓		
Automatic Valves	50138	✓	✓	✓	✓	✓		
Automatic Valves	50139	✓	✓	✓	✓	✓		✓
Automatic Valves	50140	✓	✓	✓	✓	✓		✓
Augomatic Valves	50141	✓	✓	✓	✓	✓		✓
Automatic Valves	50142	✓	✓	✓	✓	✓		✓
	50143							
	50144							
7 Gauges	50145	✓	✓	•	✓	✓		✓

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	CERTIFIED DWG REC'D	EQUIP-MENT REC'D
Pressure Lubricators	50146	✓	✓	✓	✓	✓		✓
Thermocouples	50147	✓	✓	✓	✓	✓		✓
7 Level Switches	50148	✓	✓	✓	✓	✓		
	50149							
Sewer Tie-In Line	50150	✓	✓	✓	✓	✓		
Service Agreement	50151	✓	✓	✓	✓	✓		
	50152							
Lever Transmitters & Switches	50153	✓	✓	✓	✓	✓		✓
Field Instrumentation	50154	✓	✓	✓	✓	✓		
Conditioners & Process Filters	50155	✓	✓	✓	✓	✓		
Sample Conditioners	50156	✓	✓	✓	✓	✓		
Sample Conditioners	50157	✓	✓	✓	✓	✓		
	50158							
Manual Valves	50159	✓	✓	✓	✓	✓		✓
Caustic Storage Tank	50160	✓	✓	✓	✓	✓		✓

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	ENG REC'D	EQUIP-MENT REC'D
Immersion Heater	50161	✓	✓	✓	✓	✓	✓	✓
Fuel Tank	50162	✓	✓	✓	✓	✓	✓	✓
Shipping Preparation & Freight	50163					✓		
Automatic Valve	50164	✓	✓	✓	✓	✓		
	50165							
Main Instrument Panel "A"	50166	✓	✓	✓	✓	✓		
Main Instrument Panel "A"	50167	✓	✓	✓	✓	✓		
Field Instrumentation	50168	✓	✓	✓	✓	✓		
Main Instrument Panel "A"	50169	✓	✓	✓	✓	✓		
Main Instrument Panel "A"	50170	✓	✓	✓	✓	✓		
	50171							
Main Instrument Panel "A"	50172							
Main Instrument Panel "A"	50173	✓	✓	✓	✓	✓		
Main Instrument Panel "A"	50174							
Main Instrument Panel "A"	50175	✓	✓	✓	✓	✓		

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIP-MENT REC'D
Main Instrument Panel "A"	50176	✓	✓	✓	✓	✓		
Field Instrumentation	50177	✓	✓	✓	✓	✓		✓
Field Instrumentation	50178	✓	✓	✓	✓	✓		✓
Field Instrumentation	50179	✓	✓	✓	✓	✓		✓
Field Instrumentation	50180	✓	✓	✓	✓	✓		
Field Instrumentation	50181	✓	✓	✓	✓	✓		✓
Field Instrumentation	50182	✓	✓	✓	✓	✓		✓
Field Instrumentation	50183	✓	✓	✓	✓	✓		✓
Field Instrumentation	50184	✓	✓	✓	✓	✓		✓
Field Instrumentation	50185	✓	✓	✓	✓	✓		
Valves	50186	✓	✓	✓	✓	✓		
Filter Bags	50187	✓	✓	✓	✓	✓	✓	✓
Valves	50188	✓	✓	✓	✓	✓		✓
Valves	50189	✓	✓	✓	✓	✓		✓
Automatic Valves	50190	✓	✓	✓	✓	✓		✓

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIP-MENT REC'D
Automatic Valves	50191	✓	✓	✓	✓	✓		✓
Automatic Valves	50192	✓	✓	✓	✓	✓		✓
Automatic Valves	50193	✓	✓	✓	✓	✓		✓
Check Valves	50194	✓	✓	✓	✓	✓		✓
	50195							
	50196							
Field Instrumentation	50197	✓	✓	✓	✓	✓		✓
	50198							
Field Instrumentation	50199	✓	✓	✓	✓	✓		
Field Instrumentation	50200	✓	✓	✓	✓	✓		
Field Instrumentation	50201	✓	✓	✓	✓	✓		✓
Controller	50202	✓	✓	✓	✓	✓		✓
	50203							
Instrument Field List	50204	✓	✓	✓	✓	✓		✓
Instrument Field List	50205	✓	✓	✓	✓	✓		✓

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIP-MENT REC'D
Manual Valve Packless	50206	✔	✔	✔	✔	✔		
Rubber Hose	50207					✔		✔
	50208							
Field Instrumentation	50209	✔	✔	✔	✔	✔		✔
Field Instrumentation	50210	✔	✔	✔	✔	✔		✔
Field Instrumentation	50211	✔	✔	✔	✔	✔		✔
Field Instrumentation	50212	✔	✔	✔	✔	✔		✔
	50213							
Field Instrumentation	50214	✔	✔	✔	✔	✔		✔
Field Instrumentation	50215	✔	✔	✔	✔	✔		✔
Manual Valves "Packless"	50216	✔	✔	✔	✔	✔		✔
Manual Lined But-Valves	50217	✔	✔	✔	✔	✔		✔
Main Instrument Panel	50218	✔	✔	✔	✔	✔		
Panel No. 2 "E"	50219	✔	✔	✔	✔	✔		
Panel No. 1 "D"	50220	✔	✔	✔	✔	✔		

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIP-MENT REC'D
Panel No. 4 "G"	50221	✔	✔	✔	✔	✔		
Panel No. 3 "F"	50222	✔	✔	✔	✔	✔		
Sample Panel "QA"	50223	✔	✔	✔	✔	✔		
Rav Valve Packing Pressurization	50224	✔	✔	✔	✔	✔		
Solenoid Valves	50225	✔	✔	✔	✔	✔		
Teflon-Lined Piping	50226	✔	✔	✔	✔	✔		✔
Sample Conditioners	50227	✔	✔	✔	✔	✔		
Sample Conditioners	50228	✔	✔		✔	✔		
Fittings	50229	✔	✔	✔	✔	✔		
48 Packless Valves & 18 Diaphragms	50230	✔	✔	✔	✔	✔		
Sample Conditioners	50231	✔	✔	✔	✔	✔		
Manual Knife Valve	50232	✔	✔	✔	✔	✔		✔
Safety Relief Valves	50233	✔	✔	✔	✔	✔		✔
Safety Relief Valves	50234	✔	✔	✔	✔	✔		
Vacuum Relief Valves	50235	✔	✔	✔	✔	✔		

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIP-MENT REC'D
SS Tubing	50236					✔		
	50237							
High Temperature Check Valves	50238	✔	✔	✔	✔	✔		
High Temperature Manual Globe Valves	50239	✔	✔	✔	✔	✔		
Manual Valves	50240	✔	✔	✔	✔	✔		✔
Expansion Joints	50241	✔	✔	✔	✔	✔		✔
Expansion Joints	50242	✔	✔	✔	✔	✔		✔
Manual 3-Way Valves	50243	✔	✔	✔	✔	✔		
Pump Connectors	50244	✔	✔	✔	✔	✔		✔
Diaphragm Pump	50245	✔	✔	✔	✔	✔		
Automatic Valve	50246	✔	✔	✔	✔	✔		
Bursting Discs	50247	✔	✔	✔	✔	✔		
Check Valves	50248	✔	✔	✔	✔	✔		
	50249							

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	ENG REC'D	EQUIP-MENT REC'D
Field Instrumentation	50250	✔	✔	✔	✔	✔		
Field Instrumentation	50251	✔	✔	✔	✔	✔		✔
Field Instrumentation	50252	✔	✔	✔	✔	✔		✔
Field Instrumentation	50253	✔	✔	✔	✔	✔		✔
Field Instrumentation	50254	✔	✔	✔	✔	✔		✔
Field Instrumentation	50255	✔	✔	✔	✔	✔		✔
Field Instrumentation	50256	✔	✔	✔	✔	✔		✔
Field Instrumentation	50257	✔	✔	✔	✔	✔		
Field Instrumentation	50258	✔	✔	✔	✔	✔		✔
Field Instrumentation	50259	✔	✔	✔	✔	✔		✔
Field Instrumentation	50260	✔	✔	✔	✔	✔		✔
Field Instrumentation	50261	✔	✔	✔	✔	✔		✔
Field Instrumentation	50262	✔	✔	✔	✔	✔		✔
Field Instrumentation	50263	✔	✔	✔	✔	✔		✔
Field Instrumentation	50264	✔	✔	✔	✔	✔		✔

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIP-MENT REC'D
Field Instrumentation	50265	✔	✔	✔	✔	✔		✔
Field Instrumentation	50266	✔	✔	✔	✔	✔		✔
Field Instrumentation	50267	✔	✔	✔	✔	✔		✔
Field Instrumentation	50268	✔	✔	✔	✔	✔		
Field Instrumentation	50269	✔	✔	✔	✔	✔		✔
Field Instrumentation	50270	✔	✔	✔	✔	✔		
Field Instrumentation	50271	✔	✔	✔	✔	✔		✔
Sample Conditioners	50272	✔	✔	✔	✔	✔		
Level Guage	50273	✔	✔	✔	✔	✔		
HCl Monitor	50274	✔	✔	✔	✔	✔		
HCl Monitor	50275	✔	✔	✔	✔	✔		
HCl Monitor	50276	✔	✔	✔	✔	✔		
HCl Monitor	50277	✔	✔	✔	✔	✔		
Thermostat & Finstrip Heater	50278	✔	✔	✔	✔	✔		
HCl Monitor	50279	✔	✔	✔	✔	✔		

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIP-MENT REC'D
HCl Monitor	50280	✔	✔	✔	✔	✔		
HCl Monitor	50281	✔	✔	✔	✔	✔		
Main Instrument Panel "A"	50282	✔	✔	✔	✔	✔		
Main Instrument Panel "A"	50283	✔	✔	✔	✔	✔		
Main Instrument Panel "A"	50284	✔	✔	✔	✔	✔		
Main Instrument Panel "A"	50285	✔	✔	✔	✔	✔		
Main Instrument Panel "A"	50286	✔	✔	✔	✔	✔		
Main Instrument Panel "A"	50287	✔	✔	✔	✔	✔		
Main Instrument Panel "A"	50288	✔	✔	✔	✔	✔		
Main Instrument Panel "A"	50289	✔	✔	✔	✔	✔		
Panel "E"	50290	✔	✔	✔	✔	✔		
Panel "E"	50291	✔	✔	✔	✔	✔		
Panel "E"	50292	✔	✔	✔	✔	✔		
Panel "E"	50293	✔	✔	✔	✔	✔		
Panel "E"	50294	✔	✔	✔	✔	✔		

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG RECD	EQUIP-MENT RECD
Panel "D"	50295	✔	✔	✔	✔	✔		
Panel "D"	50296	✔	✔	✔	✔	✔		
Panel "D"	50297	✔	✔	✔	✔	✔		
Panel "D"	50298	✔	✔	✔	✔	✔		
Panel "D"	50299	✔	✔	✔	✔	✔		
Panel "Q"	50300	✔	✔	✔	✔	✔		
Panel "Q"	50301	✔	✔	✔	✔	✔		
Panel "Q"	50302	✔	✔	✔	✔	✔		
Panel "Q"	50303	✔	✔	✔	✔	✔		
Panel "Q"	50304	✔	✔	✔	✔	✔		
Panel "Q"	50305	✔	✔	✔	✔	✔		
Panel "Q"	50306	✔	✔	✔	✔	✔		
Panel "Q"	50307	✔	✔	✔	✔	✔		
Panel "Q"	50308	✔	✔	✔	✔	✔		
Panel "Q"	50309	✔	✔	✔	✔	✔		

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIP-MENT REC'D
Panel Q	50310	✔	✔	✔	✔	✔		
Panel "Q"	50311	✔	✔	✔	✔	✔		
	50312							
Panel "G"	50313	✔	✔	✔	✔	✔		
	50314							
	50315							
Plastic Ball Valves	50316	✔	✔	✔	✔	✔		✔
Lined Plug Valves	50317	✔	✔	✔	✔	✔		✔
Pressure Indicators	50318	✔	✔	✔	✔	✔		✔
Pressure Guages	50319	✔	✔	✔	✔	✔		✔
Field Instrumentation	50320	✔	✔	✔	✔	✔		
Temperature Indicators	50321	✔	✔	✔	✔	✔		✔
Back Flow Preventers	50322	✔	✔	✔	✔	✔		
	50323							
SS Pipe Fittings	50324	✔	✔	✔	✔	✔		✔

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIPMENT REC'D
Flange Gasket	50325	✔	✔	✔	✔	✔		
Manual Ball Valves	50326	✔	✔	✔	✔	✔		✔
	50327							
	50328							
Porex Breathers	50329	✔	✔	✔	✔	✔		
Inline Filters	50330	✔	✔	✔	✔	✔		✔
Inline Strainers	50331	✔	✔	✔	✔	✔		✔
	50332							
	50333							
	50334							
Pipe Fittings	50335	✔	✔	✔	✔	✔		✔
Sample Panel "A"	50336	✔	✔	✔	✔	✔		
	50337							
Fume Hood	50338	✔	✔	✔	✔	✔		
SS Pipe Fittings	50339	✔	✔	✔	✔	✔		✔

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIPMENT REC'D
	50340							
Vogt Valve	50341	✔	✔	✔	✔	✔		
Sample Panel "A"	50342	✔	✔	✔	✔	✔		
	50343							
Sample Panel "A"	50344	✔	✔	✔	✔	✔		
Sample Panel "N"	50345	✔	✔	✔	✔	✔		
Sample Panel "N"	50346	✔	✔	✔	✔	✔		
Sample Panel "N"	50347	✔	✔	✔	✔	✔		
Sample Panel "A"	50348	✔	✔	✔	✔	✔		
Sample Panel "A"	50349	✔	✔	✔	✔	✔		
Sample Panel "A"	50350	✔	✔	✔	✔	✔		

EQUIPMENT PROCUREMENT STATUS

EQUIPMENT NO. & NAME	P. O. NUMBER	FUNC SPECS ISSUED	ENG SPECS ISSUED	RFQ ISSUED	RFR ISSUED	P.O. ISSUED	DWG REC'D	EQUIP-MENT REC'D
Caged Ladder	24302	✓	✓	✓	✓	✓		
Vacuum Relief Valves	29751	✓	✓	✓	✓	✓		
Check Valves	32521	✓	✓	✓	✓	✓		
Field Instrumentation	33651	✓	✓	✓	✓	✓		✓
Gasket & O-Rings	33653	✓	✓	✓	✓	✓		
Instrument Equipment List	33654	✓	✓	✓	✓	✓		
Plant Emergency Trip System	38094	✓	✓	✓	✓	✓		
Computer Components	38177	✓	✓	✓	✓	✓		